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OF THE
BOSTON SOCIETY
OF
CIVIL ENGINEERS



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BOSTON SOCIETY OF CIVIL ENGINEERS**FOUNDED 1848**

PAPERS AND DISCUSSIONS

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FIRE PROTECTION IN BUILDING DESIGN**BY EDWARD A. BARRIER AND JOHN O. TABER**

(Presented January 23, 1924.)

EDWARD A. BARRIER*

It can be fairly stated that the modern science of fire protection owes its beginning to the study given this subject in the prevention of fires in factory properties. Among the most prominent pioneers in this field was Mr. Zachariah Allen, a woolen manufacturer, during the early part of the nineteenth century, in Allendale, Rhode Island. Mr. Allen was of an inventive turn of mind and from his early days took an interest in mechanics. He first desired to study medicine on account of the opportunity it would give him for investigation and research, but as this plan was opposed by his guardian he finally took up the study of law. His love for mechanics proved too strong, however, and he went into manufacturing, devoting a large part of his time to inventions of various kinds. He developed the automatic valve for steam engines, constructed the first heating furnace for dwelling houses, before the use of anthracite, and carried out many important engineering projects, such as making the first accurate measurements of the flow over Niagara Falls.

Among Mr. Allen's many interests was that of fire prevention. He gave the matter considerable attention, in his own

* Vice-President and Engineer, Arkwright Mutual Fire Insurance Company, Boston, Mass.

plant, studying the causes of fires and devising ways of preventing them. In those early days insurance companies did not concern themselves with fire protection, considering that their sole function consisted of collecting premiums and settling for losses. When Mr. Allen endeavored to have his efforts recognized in improving the quality of his mill from a fire standpoint the insurance companies offered him no encouragement. He therefore, in 1835, organized his own insurance company, one of the fundamental purposes of which was to eliminate hazards, develop types of construction which would be fire-resisting, or at least slow-burning, and to encourage and devise means of extinguishing fires if any should occur. This was essentially the first organized effort to study fire prevention systematically.

Early Types of Construction

In those days a variety of types of construction were used. Walls might be of wood, brick or granite, with roofs of boards on joists, sometimes in factory buildings supported by wooden trusses. Roof covering usually consisted of slate or shingles, the latter sometimes embedded in mortar. Floors were usually constructed of boards or plank on joists or plank on timber, carried by wooden columns.

Pitched, joisted roofs with attics were a common type of construction, and a frequent source of trouble from a fire standpoint. Numerous fires occurred in them, and on account of their light construction they burned rapidly, while their inaccessibility made it difficult to throw water on the fire with the equipment at hand.

A development of the middle part of the nineteenth century was the mansard roof, which, while a considerable improvement over the pitched roof with attic, was far from ideal from a fire standpoint on account of the considerable mass of light wooden construction and the projecting windows, which were particularly vulnerable to attack of fires in neighboring property. An interesting anecdote is told in this connection about Edward E. Manton, President of the Boston Manufacturers Mutual Fire Insurance Company from 1865 to 1878. A young man had been sent to Mr. Manton's office on an errand, and after completing

his business was kept in conversation by Mr. Manton, who stood before one of the windows in his office overlooking the roofs of the city. He called attention to a building under construction and remarked: "Those mansard roofs will burn Boston some day." This prophetic remark was strikingly called to mind when the fire of 1872 swept through those roofs, which were a large factor in burning a considerable section of the city.

So much for a very brief survey of some of the types of construction used during the nineteenth century, but I am sure that you are all much more interested in the present than in the past.

As a general proposition it is self-evident that from a fire standpoint the use of incombustible materials in building construction is to be preferred to materials which can burn. Like all generalizations, however, this statement should be modified, as will be pointed out later. You will note that I use the term "incombustible" rather than "fireproof," for two reasons: first, there is no building material which is strictly fireproof, and second, some incombustible materials are not even "fire-resisting."

For walls, brick, concrete or the artificial stones which are being so generally used in large office buildings are quite satisfactory from a fire standpoint. The degree of fire resistance of concrete depends considerably on the nature of the aggregate, and this will be discussed more in detail in connection with column protection. Granite, which is not now used to any considerable extent, is not an entirely satisfactory material when exposed to fire, for it spalls and disintegrates badly. Sheet steel and corrugated iron are of course used only for inexpensive and usually small buildings. Although incombustible, they have poor fire-resisting qualities, for they twist and warp out of shape when exposed to even moderate fires.

Interior Construction

Coming now to the interior construction of the building, the worst type which can be used from a fire standpoint is that consisting of boards on joists for floors and roof, and which has properly been termed "quick-burning." With this type of con-

struction, a mass of light, combustible material is present, in which a fire will spread rapidly and quickly destroy the ability of the members to carry their load. Furthermore, where sprinklers are to be installed the cost of the equipment will be appreciably greater than if some of the better, more open types of floor and roof construction are used. In addition to increased cost, the sprinklers will not function as effectively, for the numerous pockets formed by the joists prevent efficient distribution of the water, both on the floor and ceiling.

The use of closed-in concealed spaces in floors or roofs adds materially to the combustible features of joisted construction. Frequent fires occur in these spaces and generally gain considerable headway before being discovered. Even after the fire is found it is hard to put it out, and the damage is therefore usually large. A recent excellent example of this is a fire which occurred at the McCormick Manufacturing Company at London, Ontario, in their Oven Building. This building was one story, constructed of concrete walls and floor, with a slightly pitched roof of boards on joists. A false ceiling was constructed of cement plaster on wire lath, forming a concealed space varying in height from one to five feet. This space contained nothing but a few electric wires in a conduit. It would have been hard for anybody except those who have had experience in fire-protection work to conceive how fire could start in such a location. Yet the watchman one day discovered smoke issuing from this concealed space, and although the fire department was promptly notified, it required three and one-half hours to extinguish the fire, notwithstanding the use of six hose streams. The roof was almost entirely destroyed, and the loss to the building was estimated by our adjuster at \$40,000 to \$50,000.

Beyond question the best type of interior construction in which wood is used is that known as "slow-burning" or plank on timber. This construction is particularly adapted to factory and loft buildings and warehouses. It eliminates the large amount of quick-burning material throughout the building, using a flat roof of heavy, substantial construction, with solid brick walls carried up to or above the roof, thus increasing the resistance to attack from fire on the outside.

The superiority of plank on timber construction has been demonstrated time and again. The most recent excellent example of this was at the Utica Knitting Company, Utica, New York. The fire started on the first floor of a three-story plank on timber building, opening five sprinklers, and to all appearances these extinguished the blaze. One of the employees closed a controlling valve on the inside of the building, and left to obtain new sprinklers to replace those which had opened. Other employees who remained in the room discovered fire in the basement and went down to extinguish it. They were unable to do this and were driven out on account of the heat and smoke. They then attempted to open the sprinkler valve but could not reach it, as the fire in the meantime had again worked its way up to the first floor. With the sprinklers shut off, the fire spread rapidly. To make matters worse, there was considerable delay in getting in touch with the fire department, owing to inefficient telephone service. When the department did arrive the interior of the building was all ablaze. Twenty-two hose streams were used, and the fire lasted four hours. Notwithstanding the seriousness of this fire, the loss *on the building* was but \$8,800, out of a *total* loss of \$143,000. There is no question but if this building had been of joisted construction it would have been totally destroyed, and the loss on building and contents greatly increased.

The use in building construction of incombustible materials, such as steel, tiles of various kinds, gypsum blocks and slabs, reinforced concrete, etc., has greatly increased in the last twenty years, and the rapid strides which have been made in determining the limitation of these materials from a fire standpoint is a tribute to the young science of fire-protection engineering. Early in my paper I referred to the difference between "incombustible" and "fireproof." The fact that these terms are not synonymous is the first big important lesson which has been learned with reference to these new construction materials, for none of them are fireproof, although the best types of concrete will withstand severe exposure from fire without serious loss.

The most striking example of the difference between "incombustible" and "fireproof" is in the case of unprotected steel members. This type of construction had not been in use long

before it became evident that even a moderate amount of fire would twist and warp the steel, bringing down the building. This is easily explained by the fact that steel begins to lose its tensile strength at 600° Fahrenheit, and at 1,000° it will carry but 50 per cent of load at ordinary temperatures. Since steel is an excellent conductor of heat, it does not take much of a fire to heat it to the failure point.

When reinforced concrete came into use it was thought that here at last was a material which could be considered fireproof, or practically so, but we now know that this statement is true only with important reservations. Among the early experiences indicating that all types of reinforced concrete are not only not fireproof but are not even satisfactorily fire-resisting was one at the Emerson Brantingham Company, Rockford, Illinois. The office building of this factory was constructed entirely of reinforced concrete and contained nothing but office furniture. On the night of January 30, 1912, at 10.30 P.M., there occurred a fire which very seriously damaged the building and incidentally showed how much of a fire can develop with nothing but office furniture to serve as fuel. Due to the fact that the building was not equipped with sprinklers, the fire got a considerable headway before hose streams were available. The concrete was considerably damaged, large pieces being spalled off from the ceilings and columns, in some cases exposing the reinforcing rods, and although it was possible to repair the building the loss was considerable.

A later and more striking case was the fire at the Thomas A. Edison, Inc., plant in West Orange, New Jersey, on December 9, 1914. The fire started at 5.20 P.M. in a one-story wooden building, in the center of the plant, containing considerable moving-picture film. On account of the nature of the occupancy the fire developed rapidly, and, in spite of the efforts of the factory fire brigade, spread to an adjacent wooden building and then into a five-story concrete building. There were no sprinklers in any of the buildings and the water supply proved inadequate, with the result that the fire, on account of the combustible nature of the contents, consisting of phonograph cabinets, wax records, motion-picture films, etc., quickly involved the greater part of

the plant and practically burned itself out. The effect of the fire on the concrete is of special interest. Many of the columns were badly spalled and quite a number sheared and failed completely. In one large section of the building the upper three floors collapsed. Notwithstanding this considerable damage the concrete construction gave a fairly good account of itself, permitting the burning of a large amount of highly combustible stock without damaging the building to such an extent that it could not be replaced at much less cost than complete rebuilding. This would have been necessary with any other type of construction. The fire showed clearly, however, that even concrete is not fireproof, nor will it protect combustible occupancy.

Hollow tile is another material which as used by itself has not lived up to expectations. It has been used in large quantities for so-called fireproofing of steel columns and floor members, the purpose being to keep the steel at a temperature below its failure point. Experience, as well as carefully controlled experiments, has shown, however, that hollow tile expands unequally, with the result that large pieces spall off and a part or the entire covering may become dislodged, exposing the steel.

Laboratory Tests

The great importance of determining the resistance of various types of construction to fire, particularly building columns, was quickly recognized by the foremost fire protection engineers, and in 1910 the Associated Factory Mutual Fire Insurance Companies and the Underwriters' Laboratories laid out a program for a co-operative and very thorough series of tests. Later, in 1914, the Bureau of Standards took part in this effort, and these three organizations shared equally the expense of what, beyond question, is the most important and extensive series of tests which has been conducted in fire protection engineering. A special furnace was constructed at the Underwriters' Laboratories in Chicago, designed so that full size building columns could be exposed to carefully controlled and determined fire conditions, while under continued load, as they would be in a building. Over 115 different types of columns were prepared

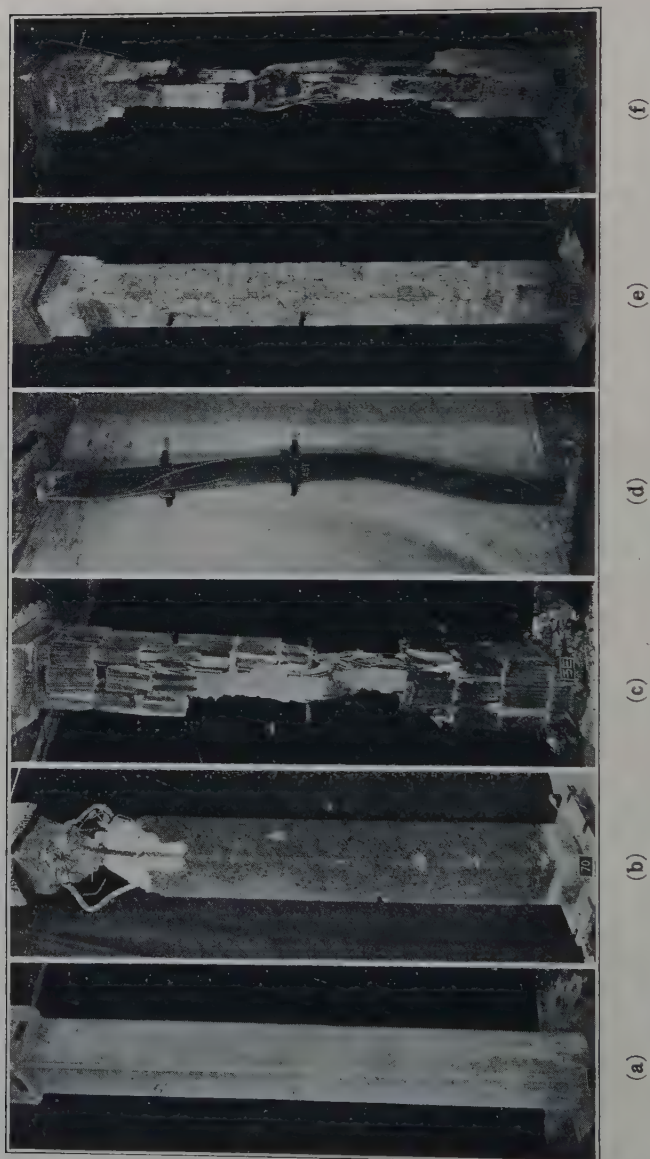


FIG. 1. — TYPICAL TESTS ON COLUMNS EXPOSED TO FIRE WHILE UNDER CONTINUED LOAD. These tests were made at the Underwriters' Laboratories in Chicago, through the co-operation of the Associated Factory Mutual Fire Insurance Companies, the Underwriters' Laboratories, and the United States Bureau of Standards,

- (a) TEST No. 70. — Square concrete column, 16" x 16"; reinforced with 4 1" square bars, tied with $\frac{1}{4}$ " steel ties, spaced 12" apart. Date poured, July 18, 1916. Date tested, September 24, 1917. Age, 433 days. Working load, 91,800 lbs. (a) shows column before test was made.
- (b) TEST No. 70. — View after exposure to fire. Column withstood fire test for the full eight-hour period. Load then increased until failure resulted, when main pressure gauge indicated 300 lbs. per sq. in., corresponding to nearly 300,000 lbs. applied load. It took 40 minutes to obtain this additional pressure, the fire being maintained at same intensity as during the eight-hour test period.
- (c) TEST No. 51. — Column made up of plate and four angles. Re-entrant portion of "H" filled with concrete, and $1\frac{1}{8}$ " of mortar placed on exposed flanges of angle bars. Entire column protected by 4" surface clay tile. Applied load about 116,000 lbs. After 14 minutes' exposure to fire there were vertical cracks in 50 per cent of tile; 18 to 38 minutes, bulging increased and vertical cracks opened to about $\frac{3}{8}$ "; 40 to 52 minutes, outer shell of tile spalled off; 1 hour 30 minutes, slight deflection noted; 2 hours 17 minutes, failure, buckling to west, maximum 6 ft. above base.
- (d) TEST No. 9. — Round cast iron, unprotected, ends restrained. Date tested, February 1, 1918. Calculated working load, 87,100 lbs. Column buckled and broke 34 minutes after start of test.
- (e) TEST No. 68. — Rolled "H" section protected by 2 $\frac{1}{4}$ " Chicago common brick set on side and end, $\frac{3}{8}$ " from flanges. Re-entrant portion of "H" also filled with brick set on end. Brick courses broken but no metal ties used. Covering placed, January 31, 1917. Column tested, June 13, 1918. Age of covering, 498 days. Calculated working load, 108,900 lbs. (e) shows column before test was made.
- (f) TEST No. 68. — View after exposure to fire. Vertical cracks as wide as $\frac{3}{8}$ " had formed at end of 15 minutes. At 25 minutes, about one-third of brick on east and west sides fell, exposing edges of steel flanges. Covering on north and south sides buckled about $\frac{1}{4}$ " away from flanges at 36 minutes, allowing heat to reach sides of flanges. Column failed at 1 hour 40 minutes.

and tested. The work covered a period of several years and cost probably in excess of \$100,000.

One particularly interesting result of these tests is the light which was thrown on the effect of the aggregate on the ability of the concrete to resist fire. Briefly stated, a limestone or limestone gravel produced the most fire-resisting concrete. Trap rock, granite, sandstone and hard coal cinders produced concretes in about the same class, and of roughly two-thirds of the fire resistance of limestone concrete. When siliceous aggregate containing water in chemical combination was used, such as chert, an inferior concrete is produced, subject to excessive cracking and spalling on exposure to fire. Such material shows roughly from one-fourth to one-third the fire resistance of limestone concrete.

Vertical Openings, Partitions and Fire Walls

Coming now to the internal arrangements of a building, the most important by far is that of vertical cut-offs. There is no single item in fire protection engineering which has been so thoroughly and frequently demonstrated as the danger of unprotected vertical openings through buildings. They act as veritable flues, like a chimney in a fireplace, and cause a fire to spread rapidly throughout the building. Not only do they increase the extent of a fire, but they may render a sprinkler system ineffective by opening a large number of heads on several floors at once, thus inducing a heavy draft on the water supply, which it may not be able to meet. Even if, as a result of abundant water and large pipes, the sprinklers are able to cope with the situation, the damage from water is greatly increased.

The most serious offenders in the way of vertical openings are elevators and stairways. In a properly designed building the elevators and stairways should be enclosed in brick or concrete towers, with fire doors at each floor, and this is now the general practice in the better type of buildings. A proper fire-resisting enclosure for the stairway is of importance not only in preventing the rapid spread of fire, but it is a considerable protection from the standpoint of safety to life. A further important advantage of the fire-resisting stair tower is the assistance which it gives to fire departments, particularly in higher buildings, for it

provides a point of vantage from which to attack the blaze. If a standpipe with hose connections is installed, the value of the stair tower is still further increased. Chief Taber may tell you more about this later. In a properly designed modern building, in which fire-resisting materials are used, if the vertical openings are properly protected it should be possible to burn up the entire contents of one floor without damaging the remainder of the building, except possibly to a limited extent from smoke and water.



FIG 2. — VALUE OF FIRE WALL IN STOPPING PROGRESS OF FIRE.

Three-story wooden shoe factory, subdivided by 12 inch brick parapeted fire wall. Door openings protected by fire doors on each side of wall. Equipped with automatic sprinklers supplied by city water and 11,000 gallon tank. Water supply for sprinklers failed, but fire was stopped at fire wall with the assistance of the fire department.

In the construction of partitions the effect on the fire hazard should be given some thought. Formerly it was not uncommon to see buildings honeycombed with light wooden partitions. These are objectionable from a fire standpoint, as they furnish a large amount of light, highly combustible fuel, particularly if they are varnished. There are many kinds of partition materials now on the market which are thoroughly satisfactory from a fire standpoint if the partition is not to serve as a fire cut-off. If, on

the other hand, it is intended to serve as a fire cut-off, the material selected should depend on the amount of protection desired. Wire lath or expanded metal with about two inches of cement plaster and hollow tile or gypsum block with one-half to one inch of cement plaster provide satisfactory fire-resisting partitions for all ordinary requirements. Hollow tile without plaster or with a thin layer is not an effective fire retardant. Even though incombustible materials are used for the partitions, an excessive amount of them should be avoided if possible, for they are more or less of a handicap in fighting a fire.

In discussing partitions I have made no reference to fire walls, for this is a subject which it is difficult to cover in a general way. The need of fire walls depends not only on the area involved but the combustibility of the contents and its value. Furthermore, in manufacturing buildings, the possible effect of a fire wall on efficient manufacturing operations must be taken into account. I may say, however, that fire walls have demonstrated their value time and again in preventing the total destruction of a building or stopping what otherwise might have been a conflagration.

Protection Against Outside Exposure

Now having briefly surveyed some of the important features which influence the fire resistance of the building to internal fires, let us consider some of the features which affect its ability to withstand external attack. First, assuming that brick, concrete or artificial stone walls are used, is the question of wooden trimmings. There is but little of this used nowadays, but in earlier types of construction it was quite common. The most objectionable in this line is the wooden cornice. This furnishes an easy point of attack for the outside fire and a means of quick entrance to the interior of the building. The danger is so great that in some cases of bad exposure fire protection engineers have asked for the removal of wooden cornices.

The only other point of particular importance from a fire standpoint in the design of the exterior of a building is the matter of window openings. Wooden frames where used provide a particularly vulnerable point and should never be used where

there is much exposure. Metal sash, which is being used more and more today, is a distinct improvement in every respect. Whether or not anything more is required depends upon the seriousness of the exposure. Plain window glass will of course stand but very little heat, and a moderate exposure will crack the glass and permit sparks and embers to enter the building. The use of wired glass is the first step in the direction of window protection, and this material will withstand considerable exposure. The glass cracks, of course, but the wire holds it in place and

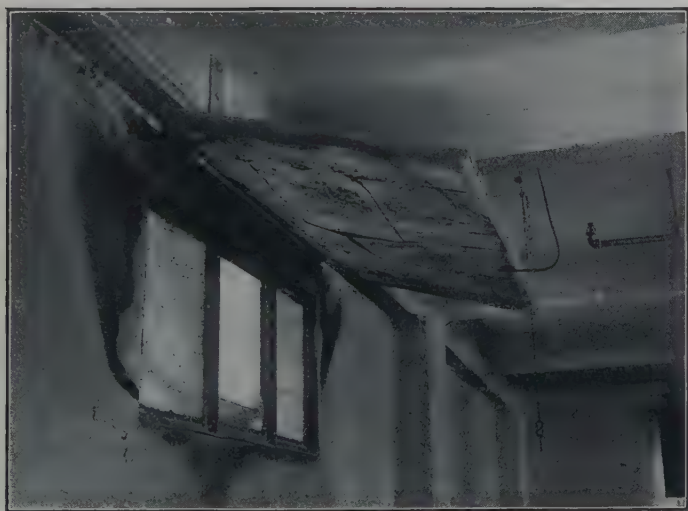


FIG. 3. — AUTOMATIC CLOSING SHUTTER PROTECTS WINDOW OPENING WHEN WIRE GLASS HAS FAILED.

prevents entrance of sparks and embers. Wired glass alone will not, however, stand up against severe exposure. The glass will melt and the radiant heat through it is sometimes sufficient to ignite combustible materials on the inside. Where a severe exposure must be faced, the wired glass should be reinforced with additional protection, such as open sprinklers or shutters. Properly designed shutters, constructed of wood, tin clad, or asbestos lined corrugated iron, provide the most effective protection for window openings. The principal objections to their

use are their unsightly appearance and the difficulty of making them automatic, so that they will surely be closed when needed. Some thought has been given to this problem by shutter manufacturers, and an effort has been made to develop a shutter which will not mar the architectural beauty of a building. Some progress has been made, and there are now on the market one or two shutters which if provided for when the building is constructed are practically out of sight.

The need of adequate window protection has been demonstrated time and again, but I will refer only to the most recent case which attracted widespread attention, namely, the fire at the Chicago, Burlington & Quincy office building in Chicago on March 15, 1922. This was a fifteen-story concrete steel frame building with the steel members protected by three inches of concrete. The windows were plain glass in metal frames. The fire originated in a one and two story brick joisted building across the street from the Burlington building, and spread to a seven-story brick building constructed of plank on heavy joists on wood columns. Although the street was ninety feet wide, the fire entered all floors of the Burlington building above the eighth, entirely consuming the contents and damaging the lower floors to a lesser extent. Although the building gave a fairly good account of itself, the interior suffered considerable damage, and this case again demonstrated that there is no such thing as a strictly fireproof building.

The best example that I know of, showing what can be accomplished with a properly designed fire-resisting building with the window openings adequately protected, is the Finished Goods Store House of the Naumkeag Steam Cotton Company, at Salem, Massachusetts. This building went through the Salem conflagration with practically no loss. In addition to proper window protection, the number and size of the windows was reduced to a minimum, and this is a very desirable thing to do if possible where a serious exposure must be faced. This idea can be carried out, of course, only in storehouses where abundant light is not an important factor.

In closing, I would like to emphasize the desirability of conferring with fire protection engineers, while the plans are being

drawn, on any points about which the building designer may be in doubt. This is much better than waiting until the building is completed and finding that it is deficient from a fire standpoint. This is the only branch of engineering that I know of where first-class advice can be obtained without charge. All insurance companies that have an engineering staff are ready to confer with building designers, and the Factory Mutual Companies, with which I am connected, consider this part of the service which they are glad to render. This applies particularly to properties insured in the Mutual Companies, but even on other properties in which we are not interested we are glad to give general advice as our contribution to the general cause of fire protection and the reduction of the \$500,000,000 bonfire which Uncle Sam stages every year.

JOHN O. TABER*

We have an exceptional opportunity here in Boston to study progress in building construction and design. The area lying between Washington Street and the harbor, and bounded on the south by Summer Street and on the north and west by Milk and Oliver streets, is roughly the area burned over by the Great Fire of 1872. The great bulk of the buildings in this area were built in the ten-year period following that fire, and so may be considered as representing the best in construction and design of the time.

From the fireman's standpoint the architects of that day did not give any large thought to fire protection in the design of their buildings. Of course, so far as the materials went they did not have the steel and concrete which we have today. Take Federal Street for example. Of the buildings on that street erected after the Great Fire there is hardly one which has since escaped having a serious fire, — a fire in which the design of the building played a considerable part. The architects of fifty years ago did learn from the Great Fire that party walls must be thicker and heavier, and they eliminated the ornamental but usually highly combustible superstructure called the mansard

* Chief of Department, Boston Fire Department.

roof. They gave little thought, however, to protecting their stair openings and such elevator shafts as existed at that time. Their buildings have proven to be generally structurally strong in the sense that the walls in them have not been carried down by the giving way of the floor timbers as they were burned off. You may not realize it, but at a serious fire in an old building the chief has to give very serious thought to the protection of his men from destruction by an early weakening of walls and timbers.

A great many laymen seem to think that what we know as a fireproof building is a perfectly safe proposition; they don't think of the contents of the building — and the contents of a building are just as combustible today as they were fifty or a hundred years ago, and they always will be, in the very nature of things. In our modern building, so far as fire protection and design go, we have two objects, first, to protect the contents from fire originating without the building — that is, outside exposure — and second, to protect the contents from an undue spread of the fire within the building itself.

Exposure from External Fires

A number of years ago we had a most peculiar fire in Boston — the Hotel Lenox fire. The building itself was non-combustible. It was divided into a large number of comparatively small rooms, and it had no contents which could develop a heavy body of fire. In the early hours of the morning a cigarette smoker set his bed afire. Without thought he rushed from his room, leaving the windows, door and transom open. Dozens of other guests did the same. A most wonderful series of drafts were set up, and the impossible had happened. It was a five-alarm fire, which resulted in no serious structural damage to the building but did result in a serious damage to contents. The fire originated on the third floor, and performed the peculiar feat of going out of the windows and back in on the fifth floor again. Now, if that cigarette smoker, when he set his bed afire, had closed his windows and then left his room, closing his transom and door, a chemical line probably would have extinguished that fire and the damage would not have extended beyond one room.

You all remember this fire; I have simply brought it up to illustrate what we want to avoid in our buildings as much as possible, — that is, the creation of drafts.

To begin with, we want good solid party walls which will withstand any heat to which they may be exposed, and which extend well above the roof. With these provided we have more or less automatically confined the fire to the building where it started, so far as the buildings on either side are concerned. The difficulty in our front and rear and in light shafts, areas, etc., is coming from the windows, and here everything depends on the exposure. The Chicago, Burlington & Quincy Railroad office building in Chicago, two years ago, is a good example. The building, a comparatively modern fifteen story office building, had the seemingly good exposure protection of an eighty-foot street (our own Federal Street is sixty feet from building line to building line), and wire-glass windows had been thought unnecessary. To make a long story short, the heat generated by the burning of some comparatively low combustible buildings was sufficiently intense to break these Chicago, Burlington & Quincy windows, let fire and heat within, with the net result of a five million dollar damage to their building and its contents. In other words, if there is any doubt in your minds about exposure hazard in your building, give the future contents of that building and the fire department the benefit of the doubt and put in wire glass. Where there is close exposure to the possibility of heavy fire, I should like to see both wire glass and standard shutters. Normally the shutters will generally be open during daylight hours, and at least part of the windows will be closed, so that the wire glass will be a tremendous help until the shutters can be closed. I should advise this on narrow streets, areas, light wells, etc.

Design within the Building

Now we have got our outside walls pretty well protected. What are we going to do on the inside? Here I think we can take a page from the naval constructor's book, and divide our building into fire-tight compartments as he divides his ship into water-tight compartments. In the first place, let us design our

building with the idea of preventing the vertical extension of the fire. In the modern building this means, in general, the elevator shafts and stair wells. If we make these so fire tight that fire cannot get into them from the surrounding areas, and *vice versa*, we will accomplish our object in an ideal way. Then our elevator shaft (non-combustible of course) will contain not only our elevators but a landing place at each floor, rather than having our elevators open directly into the floor areas themselves. Designed in this way, if space permits we get a double protection; first, the protection of the walls and doors of the shaft, and second, the protection of the wired glass forming the front of the elevator well proper. Now through these walls we have got to have doorways to give access to the floor areas. To do us any good these doors must be as good or better than standard tin-clad, and should be normally closed. In buildings carrying contents capable of developing a heavy body of fire it is going to be a big help, in confining the fire, if we have the protection of two doors, one of which is normally closed during the daytime and both of which are normally closed at night, and both of which will automatically close when tripped by some device in the watchman's office. Fusible links are a good thing to release a fire door, but they are, of course, absolutely no protection against the spread of smoke, and when the atmosphere is getting up around the 150 or 160 degrees of heat necessary to make them function, it is getting too hot to be real comfortable or safe. I want to see the doors in this building of ours close when the alarm is given, and stay closed except when opened for necessary passage through. The bulkheads on a ship are closed at once in case of a bad leak, or in case of fire; they don't wait until the water is a certain depth or a certain degree of heat has been reached. Why shouldn't we provide means for more or less automatically closing up the various parts of a building as much as possible immediately a fire breaks out? Every door we close eliminates one draft.

If we have done all the things I have suggested we have more or less cut off the immediate spread of the fire from one floor to the other. The next thing is to keep it in as small a portion of one floor as we can. In an ideal design we shall divide

our floor areas by fire walls, capable of withstanding any heat to which they may be subjected, so that the floor area between fire walls will not be much over half an acre in extent. Of course these areas will have to have doorways to the adjoining areas on the same floor, and, of course, we shall protect these openings by as many and as good doors, — operated by the same closing devices that we used on our doors into the elevator shaft.

I have given you briefly and very roughly, and without going into details, my ideal of a building from a fireman's standpoint. Of course it is either of non-combustible properly protected construction or else mill construction. In either event, if cut up and protected as I have indicated it will be ideal from a fireman's standpoint. The handling of a fire in such a building, regardless of occupancy, except explosives, will be child's play compared to what we are up against today. Of course, in painting this ideal I realize that you cannot follow it explicitly in an office building, but in general principles it can be followed even in an office building. You can follow it fairly closely, however, in mercantile and absolutely in manufacturing and warehouse buildings.

Ideal Fire Protection

Now, I am going to suggest that you put in this building, if it is a mercantile, manufacturing or warehouse building, another device of the sea — the "smoke telltale." Briefly, it is a series of tubes leading to the pilot house through which air is drawn from each compartment. A telltale wisp of smoke discloses the fact that there is a fire in compartment so and so. You can get the idea in its refinement and detail by getting in touch with the chief engineer of almost any large ocean-going liner. Of course, on land the pilot house would be the watchman's office — and here also would be our devices for tripping the fire doors and here also will be a city fire alarm box. When our watchman during the night gets a whiff of smoke from one of these smoke protectors, the first thing he does will be to pull that box. Next, he will have an elevator or elevators ready to operate to the floor from which the smoke comes. Of course we have installed in this building six-inch standpipes with outside connections, —

raise your outside connections a couple of feet above the sidewalk to get them out of the snow and ice. Then when the fire department arrives he is on the sidewalk to tell the chief that he gets smoke from the eighth floor, right-hand rear compartment. He also has available a chart showing the fire walls and doors and interior partitions on that floor. Next, we are on an elevator with two or three lengths of hose which we will connect to the standpipe on the eighth floor. In the meantime, the outside connections are being connected by hose to the nearest high-pressure hydrant. Simple, isn't it, this fireman's dream?

Just a word as to particular classes of buildings. Big unbroken floor areas are the bogey man of the fireman's existence; they seem to have been a necessary evil of the department store. A large part of the contents of the department store are highly inflammable, and of such a character that fire travels flash fashion. I hope that our future department store buildings will have their floor areas more subdivided than they are today, and that every floor will be well cut off from the floors above and below it. I am not an architect or an engineer, but it seems to me that these great floor areas could be subdivided without any large loss of efficiency as a store plant. Think it over carefully when you have a store building to design.

Now, again, remember that in a building where large quantities of absorbent material are apt to be stored, it is desirable that you provide means of egress for some of the water we may have to pour into the compartments of that building. Leaving out the element of relieving the load on the building, it's going to help a lot in lightening water damage, for what runs out through scuppers or other means won't soak down on to the other floors.

Today a *single* alarm in the down-town district brings to the fire from ten to fifteen vehicles of major fire-fighting apparatus, including perhaps ten thousand feet of hose. Think of it! If the fire has much of a start this quantity of apparatus may be doubled, tripled or quadrupled, and still the fire may not be anywhere near a conflagration, but may involve only one comparatively small building and its contents. When our present old buildings are replaced with these ideal buildings which you and I are planning, it is going to take a considerable fire to bring

out more than a couple of high-pressure wagons and a couple of ladder trucks. What is your guess as to when that will be brought about? I am afraid that none of us and perhaps none of our children will see it accomplished completely.

Remember, if you will, that fire is a good deal like a rat — it will eat its way out if it can; drafts of air help it to eat its way out if it finds any part of the building to eat on. Design and construct your building so that you can keep a hungry rat in or out of any compartment you choose, and, except for thickness of various compartments, that will furnish a pretty fair test of whether a fire department can confine a well-developed heavy body of fire to that same compartment, always bearing in mind that the structural members, if metal, must be properly and sufficiently protected from the heat generated by the fire, and if of wood, must be so large as to be slow burning.

What I have suggested contains nothing original. So far as design goes all these suggestions were long ago used in our best type of so-called "mill construction." We get a whale of a fire in the firebox of a boiler or in our kitchen stove, but it stays right there. The boiler or the stove does not burn up. The fire in the cook stove does not get into the oven. That's what we want to accomplish in our buildings. We are bound to have our furniture and merchandise get on fire occasionally. Properly designed and constructed, however, there is no reason in the world why the building itself should be seriously damaged, or why the contents of any large part of the building should be damaged or destroyed.

Boston Fire Department

Boston is probably no different in its general combustibility from all of our cities. We have here what you will pardon me for believing to be the best fire department in the country. It is as economically operated as it can be, but its very size makes it an expensive proposition, and its size is not too large for what might happen any hour of the day or night. Out of every dollar the city pays out, approximately six and one-half cents goes for the maintenance and operation of the fire department. This does not include any interest on the capital invested in houses, appa-

tus, alarm systems, water mains, pumping plants, etc., — it includes simply the operation and maintenance of the department. Think of it, six and one-half cents of every dollar paid by the city of Boston! That expense or greater must continue for a great many years, or until the great bulk of our old buildings have been replaced with buildings which resist fire. Then and then only can we cut our fire department down, both in men and apparatus. That time is coming, but none of us will live to see it.

We firemen haven't had your education and technical training, but by and large we have had a good deal of practical experience in seeing what fire will do. The modern fire department is just as much interested in preventing a fire or in retarding a future fire as it is in putting out an existing one. We haven't the least bit of worry that fire departments will be found unnecessary and that we will be out of a job. Our salaries don't depend on the number or the sizes of fires. In other words, if our practical experience is of any value to you in helping to prevent the extension of future fires, come around and put up your problems to us, and we will give you any help we can in solving them.

Discussion

HENRY F. BRYANT:* I would like to ask Chief Taber, because I know what Mr. Barrier's answer would be, what he thinks should be the minimum height of parapet walls in second-class construction — the larger part of the residential structures?

CHIEF TABER: To all intents and purposes, to be efficient the parapet wall should be 36 inches. There are physical conditions which might reduce that on many of the residential houses, but for all safe and sane construction it should be at least 2 feet.

MR. BARRIER: That's a little rough, isn't it?

WALTER W. CLIFFORD:† Of course all of you followed the Chief in his reading of the Jules Verne building of the future.

CHIEF TABER: In looking backward, we find that Jules Verne has told the truth in many cases.

* Engineer, 334 Washington Street, Brookline, Mass.

† Chairman of the Designers Section, B.S.C.E.

LEWIS H. KUNHARDT:* Perhaps the Chief would say a few words as to what the department is doing to prevent fires.

CHIEF TABER: We have a Bureau of Fire Prevention, operating forty-two men in the fire protection field. We have among this force some specialists dealing with different types of hazards, as well as some engaged in the cleaning up of debris and material of an inflammable nature that would have no value. The method is to enter a building, show their badge, be courteous, and make such corrections and remedies as they see while going through the building, and such corrective recommendations as are needed in the physical conditions of buildings. The inspection applies to storages, all parts of the construction and unprotected conditions, which with a little care could be obviated. A report is forwarded to the Fire Prevention Bureau Office, with recommendations included. We have adopted a follow-up system, whereby on the second inspection, if we find remedies have not been completed or nothing has been done, we send them a "final" notice. That is followed up by court procedure, with notice to the State Fire Marshal, Mr. Neal, of the Metropolitan District. We have obtained some convictions and sometimes we have been beaten, but in general the inspection is productive of good, and has a tendency to reduce somewhat the many fires that we have. We have in the past year made some 50,000 inspections. Of course, added to this force of forty-two are the company officers and the district chiefs. They also inspect every day. We have one condition of which you may not know. We follow up the weekly business reports which we receive, and sometimes concentrate ten or fifteen inspectors in one section of the city if bad business has affected that section. In a word, we try as far as possible to use moral suasion and common sense, and if we find some hard-headed fellows, as we often find in our designing engineers, why, then we take drastic action. In addition we have what we call an inspection card, which the district chief has, which shows the vital parts of a building, the means of egress to the top and to the basement, also vertical and horizontal openings, and the openings, if any, through into adjoining buildings. The ground plan is drawn on the back of these

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cards. But carried to the letter Z, gentlemen, that is a Jules Verne story for one hundred and fifty years hence. All of the officers have gone to school, and have been brought to as high a state of efficiency as possible in order that the attack of the fire department on a building or any part of a building may be effected with the least possible delay. We use the symbols of the underwriters, but have brought our card down from the first set-up of sixty-four different items to twelve. So you see we have really simplified it to get the essentials. We include remarks regarding absorbent conditions — vegetable and mineral — and how long we should keep the men in there. We have had some bad fires in the last year, — the worst in many years. You perhaps remember that building where government stores were stacked, and they had spread two barrels of naphthalene over to keep the moths out and then lighted fifty-three sulphur candles in order to further fumigate. The result you know. But that again proves Mr. Barrier's argument that the mill building type of construction is a good building. This was mill type — plank on timber — and after five or six hours the fire was under control. The precipitation of the floor load went through to the third floor easily, followed down to the second, then to the mezzanine floor. No walls went out. *Score one for mill type.*

MR. KUNHARDT: I am always interested in the efforts made in preventing fires. An incident which was reported to us just today may interest you, where a man had a safety can full of gasoline, and he thought it would be safer in a glass bottle, so he took a metal funnel and started to pour the gasoline into the glass bottle. A static spark resulted and the gasoline burst into flame right under his nose.

CHIEF TABER: The first time that happened was with an employee of the Boston Elevated, and they discharged the man because they thought he was drunk. A similar thing occurred at the Navy Yard when the running of a high-power machine created a static spark.

CHECKING THE AZIMUTH BY A SUN OBSERVATION

BY GEORGE L. HOSMER,* MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS

THERE might seem to be little excuse for re-telling a story as old as this one. Yet, though the story may sound familiar, many there are who have not really investigated, and since it always requires a certain effort to overcome our inertia and attack a problem seriously, any restatement of it which tends to give a new interest is not a wasted effort.

Every engineer reads in many of his textbooks, journals, etc., of the application of practical astronomy to the surveying field work which so often forms an important part of his engineering practice. But how few really make use of this information. There are a few points which must be looked into and understood, and it takes a little experience to make one familiar with the processes. So if there is some other way out of it one is likely to avoid the apparently more laborious course and follow the path of least resistance. And yet this may not be the easiest way in the long run. If an observation which can be made and computed in a few minutes will enable one to save hours of search to find a mistake it may prove the shortest way in the end.

In a few pages we shall attempt to present one kind of astronomical observation, which is of great utility, in such a way as to rob it of many of its seeming difficulties. The observation of the sun for true meridian or for true bearing possesses certain advantages which will appeal to the engineer; he can make the observation during his day's work and can see what he is doing. Pole-star observations, though capable of greater accuracy, usually require working in the dark, after the day's work is done, and perhaps at a long distance from headquarters. As a result of his observations he may quickly ascertain whether his measured angles are correct, a most important matter in a survey which progresses for many miles in one general direction and does not close upon itself. This check may be obtained

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without a long delay; the calculation may be made in a few minutes.

The chief obstacle to a more general use of this method is that most people feel that the whole matter is so unfamiliar that they are lost at the start, and have no confidence that they will be able to obtain reliable results.

Simple Method of Making a Sun Observation

If any one would like to know something of these observations let him begin by throwing the sun's image on a piece of paper held an inch or so back of the eyepiece of his transit and watching the behavior of this image for a few minutes, without any intention of making an observation or obtaining any result.

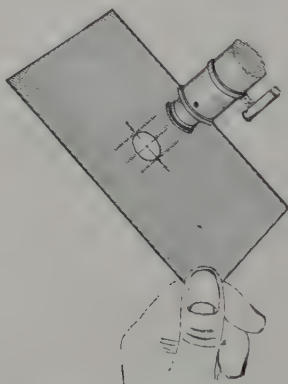


FIG. 1. — SIMPLE METHOD OF MAKING A SUN OBSERVATION
Sun's image, formed by eyepiece, shown by the bright (unshaded) portion of card.

This he may do without being at all nervous as to how the matter will turn out.

To point the telescope at the sun, hold a piece of paper back of the eyepiece and note the position of the shadow of the telescope. Turn the telescope from side to side, and up and down, so as to find the position where the telescope appears to be "end on." When it is in this position there will be a bright spot on the paper, the sun's image formed by the eyepiece.

(Do not try to look directly at the sun if you wish to preserve your eyesight for future use.) To focus this image, draw out the eyepiece tube a little way until the cross hairs are distinctly visible on the paper. Then move the objective focussing screw until the edge of the sun's disc is sharply in focus. Set the cross hairs on or near the edge of the disc and observe the sun's motion. Note both the direction of the motion and the speed, both horizontally and vertically. Move the telescope up and down, using the tangent screw on the standard, and locate the stadia hairs. These are not to be used, of course, for observations; only the middle hairs are used for pointing. Now try bisecting the disc with both cross hairs at once and reading the watch when this has been done.

One thing that is likely to be disconcerting at first is the rapidity of the sun's motion. But if you know which way it is moving and its speed you are able to anticipate a little and set the cross hairs so that they are both centered at the same instant. It is scarcely more difficult than setting on the lead line at the bow of a rapidly moving boat when locating soundings by transit. It requires a prompt decision. If you delay, the cross hairs will soon be off center and you have to begin over again.

When you are sure that you can find the sun's image at any time, and focus it and set the cross hairs either on the edges of the disc or on the center by estimation, you are ready to try an observation. In some respects the greatest difficulty of the observation has already been overcome.

To determine the true azimuth of a line set the transit over one point on the line, set the vernier at 0° , and sight at another point on the line, using the lower clamp. Then turn the telescope toward the sun, the lower clamp still remaining set. Find the sun's image on the paper and center both cross hairs on the disc. Then read the horizontal angle (to the right), the vertical angle, and the watch.

To increase the accuracy a little, take three or four such observations. The mean of the results of these readings will be better than a single result. Also, by noting the successive differences between the vernier readings and watch readings the

reliability of the observations may be judged by seeing if the rise of the sun per minute of time, or per minute of azimuth, is the same for each interval.

Calculation of Azimuth

In order to calculate the sun's bearing we must know the latitude of the place. This may be taken with sufficient accuracy from a Government (U. S. G. S.) map. We also need to know the Greenwich time. This is quickly found from the watch time. If we are in the Eastern time belt and the watch keeps standard time simply add five hours. (Be careful to make proper allowance if watch carries "daylight saving" time.) In the Central belt add six hours, etc. The result is Greenwich mean time. From the Nautical Almanac take out the sun's declination for Greenwich mean noon. Increase it or decrease it by the hourly change multiplied by the number of hours since Greenwich noon. The altitude, or vertical angle, must be corrected for refraction. This is a subtractive correction and is to be found in a table of "refraction in altitude." If no such table is at hand a close value of the correction may be obtained by employing the natural cotangent of the altitude and calling this the correction in minutes.

The latitude, the corrected declination, and the corrected altitude furnish us with three parts of a spherical triangle, of which we require one of the angles, namely, the azimuth. Among the many formulas which might be used for calculating the azimuth the following will be found convenient provided the tables used contain logarithmic versed sines:

$$\begin{array}{l} \text{vers bearing} \\ \text{(from south)} \end{array} = \frac{\cos (\text{Lat.} + \text{Alt.}) + \sin \text{Decl.}}{\cos \text{Lat.} \cos \text{Alt.}}$$

In this formula the known parts are not the sides of the spherical triangle, but are the complementary angles. The formula has been so altered that the known angles enter directly.

To illustrate this calculation suppose that on October 1, 1923, in latitude $42^{\circ} 21' \text{ N.}$, longitude $71^{\circ} 04' \text{ W.}$, the horizontal angle is turned from a stake (toward the right) to the sun's center, the vernier reading $62^{\circ} 10' 30''$, and that the corre-

sponding observed vertical angle to the sun's center is $24^{\circ} 30'$, and that the watch reads 3 h. 04 m. P.M. The Greenwich time is, therefore, 8 h. 04 m. P.M. From the Nautical Almanac we find that the sun's declination at noon is $-2^{\circ} 53' 17''.1$, and the "variation per hour" is $-58''.30$; that is, the sun is south and is going south at the rate of $58''.3$ per hour. The declination at 8 h. 04 m. is found to be $-3^{\circ} 01' 07''.4$. The cotangent of $24^{\circ} 30'$ is 2.1943; from which we find the *true* altitude to be $24^{\circ} 30' - 2'.2 = 24^{\circ} 27'.8$. Working out our solution of the spherical triangle we find the bearing as follows:

		Lat. $42^{\circ} 21'$		log sec 0.13133
		Alt. $24^{\circ} 27'.8$		log sec 0.04085
nat cos	.39372	sum	66 48.8	
nat sin	-.05266	Decl.	-3 01.1	
sum	.34106			log 9.53283
				log vers bearing 9.70501
				sun's bearing S $60^{\circ} 27'.7$ W
				horizontal angle 62 10.5
		Bearing of reference point		S $1^{\circ} 42'.8$ E

If a table of versed sines is not available then it is quite as easy to use the formula

$$\begin{array}{l} \cos \text{ bearing} \\ \text{(from south)} \end{array} = \frac{\sin \text{ Lat.} \sin \text{ Alt.} - \sin \text{ Decl.}}{\cos \text{ Lat.} \cos \text{ Alt.}}$$

Both forms apply to the northern hemisphere.

The following remarks may be of interest to any one who intends to experiment with this method. Good results will not be obtained if the sight is taken within an hour or so of noon, for the trigonometric conditions are poor. On the other hand, observations made when the sun is near the horizon, say lower than 10° altitude, are not satisfactory, because the refraction correction may be in error. If these two extremes are avoided then the bearing should be obtained within $1'$, or within $30''$, or even better, according to circumstances. The use of a larger number of pointings, a finer graduation of the circle, and a closer value of the latitude all tend to increase the precision. If a sun glass is placed over the eyepiece so that the pointings may

be made in a direct manner the result is likely to be better. And, finally, if the pointings are made on opposite edges instead of on the center of the sun the best results will be obtained.

The sun's declination may be found in the American Ephemeris, in the (smaller) Nautical Almanac, or in the booklets published by some instrument manufacturers.

For working out the azimuths rapidly in the field there are on the market a 20-inch slide rule and a circular calculating rule especially designed for this purpose. The use of these saves time, and the results are as close as are required for field checks.

ACTIVITIES OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES

THE MUSCLE SHOALS QUESTION.

With the report of the House Military Affairs Committee on the Muscle Shoals acceptance bill the way has been cleared for early action on this measure. Washington opinion seems to indicate that the bill will have only minor opposition in the House, where it will eventually be passed by a comfortable majority. The opponents of the Ford proposal for Muscle Shoals, however, are quite confident that it will be strangled in the Senate.

As this measure is likely to attract considerable attention in Congress in the near future it will be of interest to engineers to note the outstanding features of the majority report which was submitted to the House of Representatives on February 2, and to compare it with the minority report which was submitted on February 9. In reviewing these reports special care has been taken to express all of the views and only those views which are contained in the respective reports.

The majority report recites the terms of the bill which proposes to sell the two nitrate plants, Waco quarry and other improvements at Muscle Shoals to Henry Ford, and in addition to lease to the Ford Corporation, Dams No. 2 and No. 3, including power stations, etc. The bill provides, that since the Gorgas Plant was sold after the Ford proposal was drafted, substituting therefor an authorized expenditure of approximately \$3,400,000 by the Government, which was the amount received for the Gorgas Plant as a means of compensating Mr. Ford for the sale thereof. The text of the new bill is then recited in detail. Mr. Ford's proposal is reviewed and the opinions rendered by the various Government officers concerned are appended as supporting evidence for the recommendation of the Committee.

This report states that the Government has never established a policy at Muscle Shoals beyond the determination to

complete the Wilson Dam, the work on which is now in progress and nearing completion. After reviewing the extended efforts of the Government to dispose of the nitrate plant to private interests under the former administration, Mr. Madden, Chairman of the Appropriations Committee, summed up the expenditures of the Government at Muscle Shoals, which shows to June 30, 1923, a total of more than \$125,000,000. He further shows that if this enterprise is to be carried on by the Government additional expenditure of \$55,000,000 would be necessary. The report further states in substance that it requires but little reflection to convince the most conservative man that this situation should be given the prompt and earnest consideration necessary to bring about a wise and permanent solution, because of the great sum of money expended by the Government on this project, because the great nitrate plants with the millions of dollars invested in machinery, tools and appurtenances connected with the project naturally are deteriorating while standing idle, and because Dam No. 2, known as the Wilson Dam, with a total investment of fifty million, is rapidly nearing completion under the direction of army engineers.

The majority report further states that there are apparently three courses open to Congress:

1. It can authorize the necessary appropriation for completion of the dam and other facilities necessary to enable the operation of the plant in accordance with the national defense act.

2. Congress can authorize the necessary appropriations to complete the project, retaining title and leasing the power development and the plants already constructed to private persons or corporations, without actual Government operation.

3. Congress can make appropriations necessary for completion of Dam No. 2 and the construction of Dam No. 3, and authorize the sale of all plants and property of every description to an individual or corporation under certain conditions, further authorizing the leasing of power developed for a specific period on terms previously agreed upon. The latter method would mean freeing the Government from any further expense for operation or maintenance.

The conclusions of the majority to accept the latter method and the reasons therefor are substantially the same as those arrived at by the same committee of the previous Congress, that is, that the offer of Henry Ford is the only proposal which meets all of the requirements of section 124 of the national defense act, and when judged in this light the Ford offer is found to be satisfactory in all respects. These reasons are recited by the Committee in detail, but briefly they are as follows:

1. Mr. Ford's proposal is backed by a company having a capital of not less than \$10,000,000 so that there will be ample cash and responsibility to insure proper handling of the project.

2. A satisfactory fertilizer production is assured, and nitrate plant No. 2 will be maintained intact for future requirements of the country.

3. Adequate assurance has been given that the benefits of economical production of fertilizers will be passed on to the consumer.

4. A reasonable financial return is guaranteed to the Government.

5. The length of the period of the lease, namely, one hundred years, is more satisfactory than the fifty-year arrangement as provided under the Federal Water Power Act.

6. The terms of this act regulate and distribute the obligations of Mr. Ford in more detail, and more satisfactorily, both during and at the end of the lease, than would be possible under the terms of the Federal Water Power Act.

The majority concludes its report by making a comparative statement of the Ford offer with other offers that have been submitted, evidently in an effort to show that it is the most satisfactory arrangement for the development of the four fields of usefulness at Muscle Shoals, namely, the manufacture of nitrate for national defense, fertilizer production, power development and navigation improvement.

The minority report shows the magnitude of this project and maintains that it should be retained by the United States. Dam No. 2 and hydro-electric installation of 18 units will, when completed, be the largest dam in the world, and represent an investment of more than \$51,000,000. In listing the other

assets the minority points out that nitrate plant No. 1 represents an investment of more than \$12,000,000. It includes 1,900 acres of land. In addition to nitrate plant No. 1 there are large permanent substantial buildings for various smaller manufacturing purposes. Located on this tract are 125 permanent residences, with all modern improvements; also 9 miles of macadam roads; also 8 miles of sewerage; also 4 miles of standard-gauge railroads, with necessary locomotives, cars, repair shops, etc. There are paved streets and water works.

Nitrate plant No. 2, including the Waco quarry, represents an investment of more than \$67,000,000. It includes 2,300 acres of land. On this tract are 186 permanent residences, many of them with two bathrooms, including expensive electric lighting fixtures, water supply, sewers, etc. These great nitrate works include the largest buildings of their kind in the world. There are also a number of permanent buildings for various small manufacturing purposes, such as sawmills, blacksmith shops, etc.

On this tract, comprising nitrate plant No. 2, there is a hotel which is completely furnished and equipped, containing more than 100 rooms. There are 24 miles of improved roads and cemented sidewalks and streets; there are on this tract about 40 miles of standard-gauge railroad tracts; there are 20 miles of sewers; there is also a complete water works and sewerage system; and there is attached to this nitrate plant No. 2 a steam plant for the generation of electricity, known as the Sheffield steam plant, which alone cost more than \$12,000,000. This plant is in high-class running order today and is being used. There should be included in this picture the fact that there is \$500,000 worth of platinum in storage at the United States sub-treasury in New York belonging to the nitrate plants for use in a catalyst for extracting nitrogen from the air. There is also cash in the United States treasury amounting to \$3,472,487.25, recently received by the Government for the sale of the Gorgas steam plant, which it is proposed under the committee bill with the Madden amendment to immediately spend in behalf of Mr. Ford's offer for the construction of an auxiliary steam plant for his benefit.

In return for all the above, including the platinum valued at \$500,000 and the \$3,472,487.25 cash now in the United States treasury, Mr. Ford proposes to pay to the United States Government \$5,000,000, and that only in several annual installments.

The Government, if it wants to part with the steam plant for the generation of electricity attached to nitrate plant No. 2, known as the Sheffield steam plant, is now offered by one of the bidders appearing before Congress in this matter the sum of \$4,500,000 spot cash for this one unit alone.

The minority than paralleled the provisions of the Hull bill with the McKenzie bill, which is now before Congress, and claims that the latter is much superior. In brief, this bill insists on receiving an amount more nearly equal to the real value of the properties which are to be sold; it provides for the inclusion of the water power policy which has already been established by Congress, opens the way for proposals from other responsible parties, and provides for properly tying in scientific research with the modern processes involved. Further than this, the minority urges that there is no adequate regulation in the state of Alabama to control this project if it is not controlled under the Federal Water Power Act. They condemn favoring Mr. Ford for alleged philanthropic motives. They are especially opposed to subsidizing Mr. Ford in this manner, and point to the inevitable frenzied finance that will result from consummation of this proposed deal.

The minority report does not favor the Ford offer because of the foregoing and the following reasons: Because it amounts to a gift of enormous property and industrial advantage to a private citizen. It states that no Government, and especially no democracy, can single out for special favor any individual or group of individuals without grave wrong, injustice, and scandal. The minority do not believe that it is wise or proper for a Government to bestow largess upon individuals, no matter how great or good or beneficent or efficient they may be.

From this review it is evident that a fight may be expected on this measure which will undoubtedly be a long-drawn-out affair. According to present indications it will hardly be settled during the first session of the present Congress.

BOSTON SOCIETY OF CIVIL ENGINEERSFOUNDED 1848

PROCEEDINGS

MINUTES OF MEETINGS**BOSTON SOCIETY OF CIVIL ENGINEERS**

BOSTON, February 20, 1924. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, Boston.

This was a Joint Meeting of the Boston Society of Civil Engineers; the Northeastern University Section, B.S.C.E.; M. I. T. Student Chapter, American Society of Civil Engineers; Tufts Civil Engineering Society; and the Harvard Engineering Society. After a buffet supper, the Northeastern University Band played a number of selections and special musical numbers were rendered by Messrs. Greaves and Feagin of the M. I. T. Society, the former playing on a special Russian instrument and the latter on the violin.

The meeting was called to order at 8 P.M. by the President, Frank M. Gunby. There were about 200 present.

The minutes of the previous meeting were approved as printed in the February JOURNAL.

The Secretary announced the names of those elected to membership by the Board of Government at a meeting held today.

Members: Matthew J. Cummings, G. Gale Dixon, Freeman H. Horton*, Francis H. Kingsbury, Frederick A. Mahoney, Ransom Rowe.†

The President then introduced Allen Hazen, of the firm of Hazen & Whipple, New York, who spoke on "The Treatment of Hudson River Water at Albany and Poughkeepsie, New York." Messrs. Leonard Metcalf and Desmond FitzGerald spoke informally on the general subject of Mr. Hazen's paper.

Both the President and Secretary welcomed the members of the student societies and expressed the hope that they would feel free to attend the meetings of the Society whenever they desired.

After another selection by the Northeastern University Band the meeting adjourned at 9.30 P.M.

J. B. BABCOCK, *Secretary*.

SANITARY SECTION

BOSTON, February 6, 1924. — A meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening in the Library, being called to order at 8 P.M. by Chairman John P. Wentworth.

A paper entitled "Elimination of Odors" was read by Almon L. Fales. Following this paper there was a discussion of the subject by Messrs. Wright, R. S. Weston, Marston, Horne, Fair, Gammage and Professor Porter.

It was voted that the Chairman appoint a committee to nominate officers for next year.

The attendance was 31.

HARRISON P. EDDY, Jr., *Clerk*.

DESIGNERS SECTION

BOSTON, February 13, 1924. — The regular February meeting of the Designers Section of the Boston Society of Civil Engineers was called to order at 6.10 P.M. by Chairman Walter W. Clifford.

* Transferred from Grade of Junior.

† Transferred from Grade of Associate.

The report of the December meeting was read and approved.

The chairman introduced Mr. Frederic H. Fay, of Fay, Spofford & Thorndike, Consulting Engineers, Boston, who spoke upon "The Design of Terminals and Warehousing Facilities."

Mr. Fay illustrated his talk by a large number of lantern slides, showing terminals and warehouses in different parts of the world. He described in detail some of the developments in this country.

Mr. John Ayer, of the firm of Fay, Spofford & Thorndike, spoke at the close of Mr. Fay's talk, describing a terminal on the Pacific Coast visited by him last summer.

An open discussion followed the talk.

Mr. J. Stuart Crandall moved that the chairman appoint a committee of five to work for the advancement of the Port of Boston, to co-operate with the existing agencies, such as the Chamber of Commerce and the Boston Planning Board, and analyze the possibilities of development. Motion seconded and passed.

There were 60 members and visitors present.

The meeting adjourned at 8.05 P.M.

WALDO F. PIKE, *Clerk.*

NORTHEASTERN UNIVERSITY SECTION

BOSTON, February 1, 1924. — A meeting of the Northeastern University Section of the Boston Society of Civil Engineers was held today at Jordan Hall, Huntington Avenue. The meeting was opened at 12.05 P.M. with selections by the Northeastern University Band. To this meeting the student body of the University was invited, there being about 600 members and guests present.

Chairman Harold W. Kelly presided at the meeting and introduced Mr. James W. Rollins, of the engineering firm of Holbrook, Cabot & Rollins, who spoke on "Deep Foundations."

Mr. Rollins discussed many civil engineering feats of prominence, the progressive steps of construction being shown on the screen. He told of the difficulties encountered in the con-

struction of the interstate bridge between Maine and New Hampshire at Portsmouth. Other accomplishments discussed were the construction of the Boston Dry Dock; the largest stone arch in the country, at Bellows Falls, Vermont, over the Connecticut River; and the building of the three span bridge over the same river at New London, Connecticut.

The meeting adjourned at 1.15 P.M.

FRED W. CHASE, Jr., *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[March 15, 1924]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

CONANT, ELBRIDGE ROBBINS, Brookline, Mass. (Age 58, b. Acton, Mass.) Graduate of Massachusetts Institute of Technology. Experience: one year on railway construction; one and one-half years on sewer construction; and about one year on miscellaneous engineering work; between October, 1892, and March, 1913, was with U. S. Engineers Department, with headquarters at Savannah, Ga. During this period was engaged upon river

and harbor improvements and construction of fortifications, also in charge of making hydrographic surveys. In 1913 he resigned position with the government to take up municipal work, and was chief engineer of Savannah, Ga., until March, 1919; 1919-20 was with Glynn County and Brunswick, Ga., on highway construction; 1921, town manager for Mansfield, Mass.; 1922-23, surveyor, Department of Highways, Manchester, N. H.; is at present consulting engineer. Refers to H. P. Eddy, G. C. Whipple.

FOX, VERNALD WADSWORTH, North Attleborough, Mass. (Age 23, b. Alton, Me.) Graduate of high school and a student at Northeastern University in electrical and mechanical engineering for one year; from July, 1921, to September, 1922, worked; later attended Tufts Engineering School; through the summer of 1923 was a draftsman in department of bridges and buildings, Boston & Maine Railroad; then with O. H. Tripp, Rockland, Me., as draftsman and general assistant until January, 1924. Refers to Robinson Abbott, W. J. Alcott, E. R. McCarthy, E. D. Mortenson and O. H. Tripp.

JAGGER, JAMES EDWIN, Holyoke, Mass. (Age 22, b. Holyoke, Mass.) From October, 1920, to May, 1921, at Massachusetts Institute of Technology; June, 1921-October, 1922, was assistant to the resident engineer on hydro-electric development, Holyoke Water Power Company; October, 1921-May 1922, at M. I. T.; the summer of that year in charge of party on street and sewer surveying; August and September at M. I. T. surveying camp, and October to May, 1923, at M. I. T.; worked the summer of 1923 with the Holyoke Power Company in charge of boiler and turbine foundations; at present attending M. I. T. Refers to J. B. Babcock, H. K. Barrows, R. E. Barrett and C. M. Spofford.

WILLEY, CLYDE CHESTER, Manchester, N. H. (Age 20, b. Woodsville, N. H.) After graduating from high school entered Northeastern University, taking civil engineering course. During the work periods has been rodman with Fred W. Stowers at Methuen, Mass. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls and W. E. Nightingale.

For Transfer

FLYNN, FRANCIS T., Dorchester, Mass. (Age 26, b. Roxbury, Mass.) Graduate of English High School in 1915, of Lowell Institute in 1917, a student at Northeastern University, 1917-18, and at present matriculating at Boston University, specializing in real estate. During the summers of 1912-13 was chainman in the Public Works Department, city of Boston; 1915-19, was draftsman, inspector and estimator with the Boston Wharf Company; 1920-24, rodman, inspector and draftsman with the Boston & Maine Railroad, and is at present with this railroad. Refers to S. P. Coffin, R. E. Macaulay, J. J. Rourke, D. P. Steward and W. A. Woods.

LIST OF MEMBERS

ADDITIONS

COHEN, MORRIS.....	68 Nightingale St., Dorchester, Mass.
DIXON, G. GALE.....	1120 Tremont Bldg., Boston, Mass.
KINGSBURY, FRANCIS H.....	141 State House, Boston, Mass.
MAHONEY, FREDERICK A.....	226 M St., South Boston, Mass.
MESERVE, GEORGE H., Jr.....	1 Washington Pl., Medford, Mass.
SHAPIRO, DAVID.....	456 Hope St., Fall River, Mass.
SHUMAVONIAN, SORUN P.....	383 Geneva Ave., Dorchester, Mass.
SIMPSON, EDWARD J.....	407 Adams St., Dorchester, Mass.
WICKERSON, CLARENCE.....	18 Briarfield Rd., Milton, Mass.
WYNER, HENRY I.....	c/o D. H. Miller, 43 Brookline Ave., Brookline, Mass.

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EWING, WILLIAM C.....	Child Federation, 1506 Locust St., Philadelphia, Pa.
FOSTER, WILLARD M.....	82 Factory St., Nashua, N. H.
HALE, HAROLD W.....	c/o Spring Brook Water Supply Co., 30 N. Franklin St., Wilkes-Barre, Pa.
HARTWELL, HERBERT C.....	31 St. James Ave., Boston, Mass.
LEE, EDWARD G....	c/o Central Maine Power Co., Eng'g. Dept., Waterville, Me.
LOTHROP, ERNEST E.....	21 Allston Place, Fitchburg, Mass.
MORSE, WILLIAM P.....	City Engineer, City Hall, Newton, Mass.
PORTER, ARTHUR P.....	c/o C. & O. Ry. Bridge Dept., Rm. 1807, First Nat'l Bk. Bldg., Richmond, Va.
WHITMORE, HAROLD C.....	c/o Stone & Webster, Inc., Iron Mountain, Mich.
WINSLOW, EARL H.....	c/o Mrs. Sarah Gumbert, Springdale, Pa.
WRIGHT, FRANK V.....	1180 Mass. Ave., Arlington Hts., Mass.

DEATH

WINSLOW, FREDERIC I.....	February 21, 1924
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LIBRARY NOTES

RECENT ADDITIONS TO THE LIBRARY

U. S. Government Reports

Water Supply Papers, Nos. 489 and 492.

Municipal Reports

Boston, Mass. Annual Report Transit Commission. 1922.

Boston, Mass. Boston's Streets. 1923.

Medford, Mass. Annual Report Water & Sewer Commissioners. 1922.

Providence, R. I. Annual Report Water Supply Board. 1923.

Miscellaneous

American Railway Engineering Assoc. Manual. 1921.
Gift of J. B. Babcock.

Centrifugal Pumps. R. L. Daugherty.

City Pavements. F. S. Besson.

Depreciation of Public Utility Properties. Henry Earle Riggs.

Design of Diagrams. Hewes & Seward.

Electricity and Magnetism for Engineers. 2 vols. Harold Pender.

Electric Power and Light Companies of U. S. Bonbright & Co.

Engineering and Building Foundations. Charles Evan Fowler. Part 1.

Hydraulic Turbines. R. L. Daugherty.

Hydro-Electric Power Stations. Rushmore & Lof.

Hydro-Electric Power. 2 vols. Lamar Lyndon.

Hydrology. Daniel W. Mead.

Machine Design, Elements of. O. A. Leutwiler.

Machinery Foundations and Erections. Terrell Croft.

Mechanics of Machinery. Robert C. H. Heck.

Minutes of Proceedings, Institution of Civil Engineers.
London. Vol. 216.

Motor Transportation for Merchandise and Passengers.
Percival White.

Railroad Electrification. Arthur J. Manson.

Rural Highway Pavements. Harger. Gift of Publisher.

Steam Power Plant Engineering. George F. Gebhardt.

Steel and Timber Structures. Hool & Kinne. Gift of
Publisher.

Steel Erection, Handbook of. M. C. Bland.

Tested Rules for Power Station Jobs. Edited by R. L.
Shepherd.

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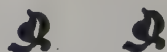
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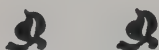
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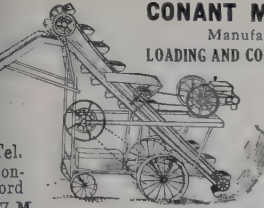
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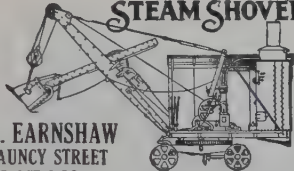
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